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May 1985

# **Behavioral Chemicals Produced by *Heliothis* Species**

Bibliographic Data Base, 1964–83

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# Behavioral Chemicals Produced by *Heliothis* Species

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Behavioral Chemicals Produced By *Heliothis* Species:  
Bibliographic Data Base, 1964-1983

M. N. Inscoe, D. W. Bushman, and R. L. Ridgway

## INTRODUCTION

The rapid worldwide increase in the volume of scientific publications is causing scientists increasing difficulty in locating pertinent literature references and maintaining current reprint files. Few scientists now have sufficient time to make comprehensive literature searches in the library, and maintenance of files of index cards or punched cards is excessively cumbersome and time consuming. These methods are being superseded by computerized systems, including bibliographic update services such as the Current Awareness Literature Service of the National Agricultural Library (NAL) (Anonymous, 1984) and bibliographic documentation systems that permit on-line searching, such as AGRICOLA, the bibliographic data base of NAL (Gilreath, 1984; Longo and Machado, 1981). These systems aid in locating pertinent citations, but a method of organizing the information obtained from the citations thus located is also necessary.

FAMULUS, a data base management system developed for indexing and retrieving citations in reprint files of research scientists and made available through NAL (Burton et al., 1969, revised 1971; Cittadino et al., 1977; Burton, 1981; Ashley, 1981; Stetka, 1983) can be used to develop a personal computerized information system. Among the large numbers of software programs that have become available for use on personal computers (Taylor, 1984) are text-oriented data base management programs, suitable for bibliographical data files (Jacobson, 1984); such software, judiciously selected, could also be used for the development of personal bibliographic data bases.

Through careful indexing of the citations in personal reprint files, such an information system can be used to develop specialized bibliographies for individual needs. A bibliography thus generated (e. g., Kulhavy and Johnson, 1983) is not always of general interest, but it can be extremely valuable for a specialized audience having interests in a specific field and can eliminate much duplication of effort.

Using FAMULUS, a specialized data base on behavioral chemicals produced by Heliothis species was developed to support several ongoing research projects. This data base can be used in various ways to organize and index available information on the subject. A major application has been the generation of this bibliography, which was prepared to facilitate communication with cooperators and other interested scientists in the United States and throughout the world.

Behavioral chemicals from Heliothis species provide a particularly appropriate subject for a specialized bibliography because of the economic importance of the genus and the diversity of the behavioral chemicals associated with the different members of the genus.

Heliothis species are found worldwide and many of the known species are economically important pests of a wide variety of crops (Reed, 1982). The corn earworm, H. zea (Boddie), the tobacco budworm, H. virescens (F.), and the Old World bollworm, H. armigera (Hübner), in particular, are considered major pests of corn, legumes, vegetables, and other crops. Much has been written about these insects; a comprehensive computer-generated bibliography on H. zea and H. virescens, published in 1978 (Kogan et al., 1978), contained 5178 citations. Similarly, the literature dealing specifically with Heliothis pheromones is increasing rapidly, as evidenced by the 221 citations in this bibliography.

### Scope

This bibliography includes citations dealing specifically with compounds emitted by Heliothis species that affect the behavior of conspecific insects or insects of other species, as well as with synthetic analogs of such compounds. However, the listings are not limited to chemical aspects; the role of these compounds in studies of insect behavior and ecology is also covered. Since a major requirement in the identification of a behavioral chemical is a suitable bioassay, reports on insect behavior, particularly mating behavior, are also included.

The largest group of citations, by far, is made up of those dealing with sex attractant pheromones emitted by the adult females. This is a broad area that covers subjects such as isolation and identification of the pheromones, synthetic pheromone analogs, the role of pheromones in mating behavior, interspecific attraction or other interspecific interaction, the behavior elicited by individual pheromone components, the use of pheromone traps in monitoring and detection, and potential applications of pheromones in pest management.

Other types of compounds that are produced by Heliothis species and affect insect behavior are also included. Chief among these are the kairomones, which attract or stimulate parasitoids or predators to search for eggs, larvae, or adults.

Since coverage is limited to insect-produced compounds or their synthetic analogs, the area of plant-host interactions is beyond the scope of this bibliography; and plant-derived chemicals, such as feeding stimulants and feeding deterrents, are not covered. Also omitted are papers on various synthetic chemicals, such as oviposition attractants.

## Sources

Citations for this bibliography were obtained from personal files, computer-generated Current Awareness reference listings provided by NAL, a literature search made by C. Bebee of NAL; subsequent searches of AGRICOLA; and computer output supplied by Dr. Stinner from his computer-based searchable file. Coverage is through 1983, but citations obtained from an AGRICOLA update in July 1984 and by scanning a few specific journals (Ann. Entomol. Soc. Amer., Can. Entomol., Environ. Entomol., J. Chem. Ecol., J. Econ. Entomol., and J. Insect Physiol.) through the June 1984 issues are included. Whenever possible, hard copy of each citation was obtained for indexing purposes.

## Organization

The information presented in each entry includes a computer-assigned entry number, authors' names, date of publication, title of citation, publication, NAL call number, and keywords. The citations are listed alphabetically by author; alphabetization was done by computer on FAMULUS, but in a few cases, where citations by a given author appeared out of sequence because of the inconsistent use of "Jr.", the order was changed. Underlining that was omitted in making entries in FAMULUS was inserted in the final version of the text.

## Keywords

A restricted vocabulary was used in assigning keywords for use in generating the subject index; each term was used with a very specific meaning, as described below. In assigning keywords, an attempt was made to consider four general areas for each citation: the research approach(es) used; the subject(s) of the research, the insect or insects mentioned in the citation, and any pertinent compounds mentioned by name. The combination of keywords from these four categories listed for each citation allows for varying degrees of selectivity in using this bibliography.

The following is an alphabetical listing of the keywords used, with an explanation of the specific meaning attached to each one or the conditions under which each is assigned to a citation:

analysis -- studies involving chemical analytical methodology.

behavior -- reports on the actions of live insects (in the laboratory or field) in response to experimental or natural stimuli.

bioassay -- any test or study done in the laboratory that involves live insects (excluding electrophysiological studies).

cage test -- any test done outside the laboratory, but in a restrictive environment such as a field cage, greenhouse, or wind tunnel.



control strategy -- the citation deals with chemical mediation of insect behavior as a tool in insect management programs.

degradation product -- substance(s) produced by the chemical degradation of compounds dealt with in this bibliography.

disruptant -- compound(s) causing a reduction in mating or mating behavior by interfering with mating communication. In the citations, these compounds are denoted by terms such as mating disruptant, deterrent, or inhibitor.

electrophysiology -- studies in which electrophysiological techniques such as electroantennograms (EAG) are used.

field test -- any test done with live insects outside the laboratory in an unrestricted environment (cf. cage test).

formulation -- a combination of active and inactive ingredients that forms a system to deliver active ingredients to the environment.

hybrid -- the behavior and progeny associated with interspecific matings.

identification -- studies in which specific compounds are chemically identified.

interspecific interaction -- studies in which natural or synthetic pheromone components or live insects were found to attract or repel insects of other species.

irradiation -- the use of irradiation to produce sterile insects or the effect of such treatment on insects or their behavior.

isolation -- studies in which behaviorally active compounds are isolated from insects, by means such as extraction or concentration of volatiles, and are partially purified and characterized (through bioassay, EAG, etc.) but not necessarily identified chemically.

kairomone -- a compound or compounds, produced by an insect, that elicits in a receiver of another species a behavioral or physiological response that is favorable to the receiver, but not to the emitter.

male pheromone -- a pheromone produced by the males of a given species, rather than by the females.

migration -- the dispersal of insects, excluding dispersal within a limited local environment such as dispersal within a greenhouse or dispersal within a single field.

monitoring -- field studies in which insect population levels or movements are examined by traps baited with natural or synthetic pheromones. This keyword is also used for citations dealing with survey or detection.

morphology -- studies of the morphology of a given insect in relation to pheromone production or reception.

parasitoid -- an insect that, in at least one stage of its development, lives in close association with an insect of another species and derives its energy from this insect,

and in so doing, kills the host insect. This keyword excludes insects that are strictly predaceous.

phylogeny -- the systematics of a given insect.

physiology -- studies of the physiology of a given insect

population density estimation -- studies in which a method for estimating population densities is given and tested in such a way that actual numerical estimates are presented in the study.

sex pheromone -- this term is used here specifically for a compound or mixture of compounds emitted by a female insect that mediates the sexual behavior of receiving male insects of the same species. A citation that refers to the use of live females or crude extracts of females as bait in traps is assigned this keyword.

sex pheromone analog -- a synthetic compound that is similar in structure to a sex pheromone component of a given species and that elicits similar behavior in receiving insects of that species (often referred to as a parapheromone in the citations).

sex pheromone precursor -- a compound found in an insect that is a proven or putative intermediate in the biosynthesis of a pheromone.

synthesis -- studies which present a synthetic route to a chemically identified compound.

synthetic sex pheromone -- a synthetic compound or mixture of compounds identical in structure to one or more components of the natural sex pheromone of a given insect species.

trap design -- studies in which the efficacy of different trap designs is tested.

trapping -- studies which specifically examine the use of live insects, extracts of live insects, or synthetic compounds for trapping insects in the field. Many references that mention the use of trapping have not been assigned this keyword because the trapping was not the focus of the research.

vapor distribution -- studies in which the atmospheric distribution of various compounds is analyzed after the compounds have volatilized from a source.

In addition to the terms listed above, the keywords also list specific insects and compounds. All insects mentioned in a citation are not necessarily listed; rather, only those insects that have some involvement with Heliothis behavioral compounds are included. When the authors of a citation have used an insect name other than that in general use (e. g., Helicoverpa armigera, Heliothis obsoleta, or Heliothis punctiger), the more familiar name is also listed.

The compounds listed for a given citation are those that are specifically mentioned by name; Chemical Abstracts nomenclature

is used. As with insect names, all compounds mentioned in a citation are not necessarily listed, only those that have relevance as behavioral chemicals of Heliothis. Those chemicals that are not mentioned by name in a citation but are referred to in a manner sufficiently specific to allow no uncertainty as to the compounds involved are also listed. For example, "the 7-component pheromone of H. virescens" refers to a specific mixture of compounds, and all seven compounds are included in the keywords when that phrase is used. However, no compounds are listed for those citations that refer to "synthetic pheromone" or "pheromone trap" without specifying the components of the pheromone mixture or giving a specific literature reference.

#### Uses

In addition to aiding scientists involved specifically with Heliothis pheromones, the material in this bibliography will be of interest to scientists working in various areas of basic research, such as studies of biosystematics or mechanisms of olfaction, as well as in applied research, in projects aimed at delineating pathways of migration, improvement of methodology for detection or monitoring, and development of effective management strategies.

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